

NATIONAL TRANSPORTATION SAFETY BOARD

Vehicle Recorder Division
Washington, D.C. 20594

January 4, 2016

Cockpit Displays – Recorded Flight Data

Specialist's Factual Report
By Bill Tuccio, Ph.D.

1. EVENT SUMMARY

Location: Ketchikan, Alaska
Date: June 25, 2015
Aircraft: de Havilland DHC-3
Registration: N270PA
Operator: Promech Air, Inc.
NTSB Number: ANC15MA041

On June 25, 2015, about 1215 Alaska daylight time (AKDT), a single-engine, turbine-powered, float-equipped de Havilland DHC-3 (Otter) airplane, N270PA, sustained substantial damage when it impacted mountainous tree-covered terrain, about 24 miles northeast of Ketchikan, Alaska. The airplane was being operated under the provisions of 14 *Code of Federal Regulations* Part 135, as an on-demand visual flight rules (VFR) sightseeing flight when the accident occurred. The airplane was owned by Pantechnicon Aviation, of Minden, Nevada, and operated by Promech Air, Inc., of Ketchikan. The commercial pilot and eight passengers were fatally injured. Marginal visual meteorological conditions were reported in the area at the time of the accident. The flight departed a floating dock located in Rudyerd Bay about 44 miles northeast of Ketchikan about 1200 for a tour through Misty Fjords National Monument Wilderness. A company VFR flight plan was in effect. At the time of the accident, the flight was returning to the operator's base at the Ketchikan Harbor Seaplane Base, Ketchikan.

2. RECORDED FLIGHT DATA GROUP

A recorded flight data group was not convened.

3. DETAILS OF INVESTIGATION

The National Transportation Safety Board (NTSB) Vehicle Recorder Division received the following electronic devices:

Recorder Manufacturer/Model: **Chelton¹ Integrated Display Unit (IDU)**
Recorder Serial Number: **36519 (tray serial number 34750)**

Recorder Manufacturer/Model: **Chelton IDU**
Recorder Serial Number: **34790 (tray serial number 35743)**

¹ Units were built by Wulfsberg Electronics in 2003. Chelton subsequently acquired Wulfsberg. Cobham plc subsequently acquired Chelton. Genesys Aerosystems subsequently acquired Chelton.

3.1. Chelton IDU

The IDU units are identical part numbers and are configured to operate as primary flight displays (PFD) or multi-function displays (MFD). Using external sensors, including solid state Air Data and Attitude Heading Reference System (ADAHRS), the PFD displays aircraft parameter data including altitude, airspeed, attitude, vertical speed, and heading. The MFD displays navigational information by way of a moving map. Additionally, the units in this accident included a terrain awareness and warning system (TAWS) that may provide aural and color-coded warnings of terrain depending on pilot selections. As part of the TAWS system, the PFD is capable of providing a profile view of terrain ahead of the aircraft ("synthetic vision"). The FAA's Instrument Flying Handbook (FAA-H-8083-15B) uses the Chelton IDU to explain the concept of synthetic vision, stating,

"Synthetic vision provides a realistic depiction of the aircraft in relation to terrain and flightpath. Systems such as those produced by Chelton Flight Systems, Universal Flight Systems, and others provide for depictions of terrain and course. Figure 5-46 [figure 1 in this report] is an example of the Chelton Flight System providing both 5-dimensional situational awareness and a synthetic highway in the sky, representing the desired flightpath. Synthetic vision is used as a PFD, but provides guidance in a more normal, outside reference format." (Chapter 5)

Figure 1. Chelton display as depicted in the FAA Instrument Flying Handbook.

Figure 5-46. The benefits of realistic visualization imagery, as illustrated by Synthetic Vision manufactured by Chelton Flight Systems. The system provides the pilot a realistic, real-time, three-dimensional depiction of the aircraft and its relation to terrain around it.



Each IDU contains two internally mounted flash memory devices (PCMCIA format) capable of logging flight data. Figure 2 shows a screen capture from the Chelton

Installation Manual² of data parameters potentially recorded by each IDU once per second; the actual parameters recorded varies depending upon installation. The recording logic retains up to five hours of data from each of the last five flights. The recording begins after the pilot acknowledges the installed database dates by pressing a button on the IDU bezel and after internal diagnostics verify primary sensors are available. Additionally, every five seconds the IDU snapshots two binary files: (a) external parameters received by the IDU in an “ac.dat” file and (b) internal menu parameters indicating how the system was being operated in the “settings.dat” file.

The units installed in this aircraft conformed to Technical Standard Orders (TSOs), including TSOs: C2d, C4c, C6d, C8d, C10b, C113, and C146a.

Figure 2. Potential parameters recorded by each IDU.

First Line (Flight)	Second Line (Engine #1)	Third Line (Engine #2)
Latitude (°)	RPM	RPM
Longitude (°)	Fuel Flow (GPH)	Fuel Flow (GPH)
MSL Altitude (ft)	Aux. 1	Aux. 1
Pitch Angle (°)	Left Fuel (Gal.)	--
Bank Angle (°)	Right Fuel (Gal.)	--
Heading (° Mag.)	Fuel Pressure (PSI)	Fuel Pressure (PSI)
Track (° Mag.)	Aux. 5	Aux. 5
IAS (kts)	Oil Temperature (°F)	Oil Temperature (°F)
TAS (kts)	Oil Pressure (PSI)	Oil Pressure (PSI)
Ground Speed (kts)	Volts	Volts
VSI (fpm)	EGT #1 (°F)	EGT #1 (°F)
Glidepath (°)	CHT #1 (°F)	CHT #1 (°F)
G-force	EGT #2 (°F)	EGT #2 (°F)
Wind Speed (kts)	CHT #2 (°F)	CHT #2 (°F)
Wind Direction (° Mag.)	EGT #3 (°F)	EGT #3 (°F)
OAT (°F)	CHT #3 (°F)	CHT #3 (°F)
Density Altitude (ft)	EGT #4 (°F)	EGT #4 (°F)
Fuel Totalizer Qty. (Gal.)	CHT #4 (°F)	CHT #4 (°F)
--	EGT #5 (°F)	EGT #5 (°F)
--	CHT #5 (°F)	CHT #5 (°F)
--	EGT #6 (°F)	EGT #6 (°F)
--	CHT #6 (°F)	CHT #6 (°F)
--	Aux. Temp. 1 (°F)	Aux. Temp. #1 (°F)
--	Aux. Temp. 2 (°F)	Aux. Temp. #2 (°F)
--	Induction Temperature (°F)	Induction Temperature (°F)

3.1.1. Chelton IDU Data Recovery

Both IDUs sustained minor impact damage. Figure 3 shows the IDU serial number 36519 on the left and IDU serial number 34790 on the right. Figure 4 shows the PCMCIA cards being removed from one of the units. One card had a capacity of 512MB, containing the terrain database and other maps; the other card had a capacity of 256MB, containing the

² Chelton Flight Systems EFIS-SV Installation Guide, 64-000038 Revision C.

flight log, “ac.dat,” and “settings.dat” files. These files were copied off the card using a PCMCIA card reader.

Figure 3. Both Chelton IDUs.

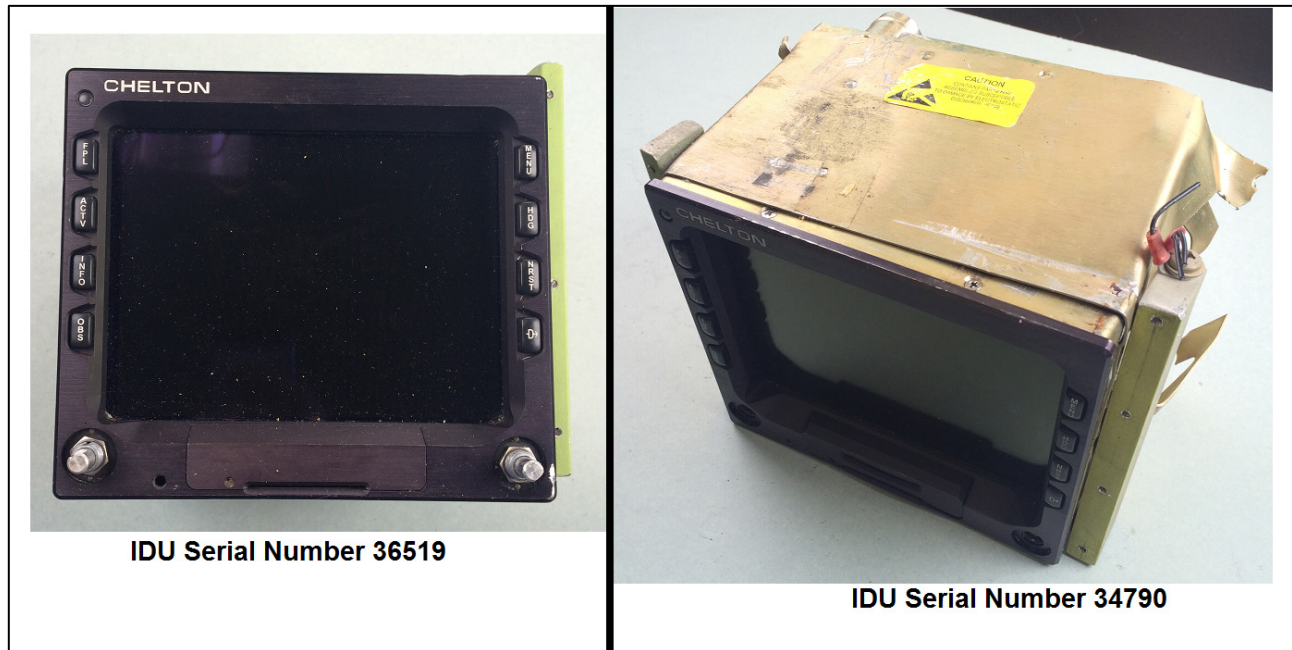


Figure 4. PCMCIA cards being removed from one of the units.



3.1.2. IDU Data Description

Each IDU flight log recording contained records of five power cycles corresponding to the last five flights. All five flights are discussed in this report. Data from both IDUs were

compared and confirmed to contain the same data; as such, only the data from IDU serial number 36519 are used in this report.

3.1.3. IDU Engineering Units Conversions

The IDU records information in engineering units; therefore, no conversions were necessary. Where applicable, changes may have been made to ensure the parameters conform to the NTSB's standard sign convention that climbing right turns are positive (CRT=+).³

Appendix A lists the IDU parameters verified and provided in this report.

3.1.4. IDU Settings Data

With assistance from the manufacturer, the ac.dat and settings.dat files were decoded. These files contained 281 values, shown in attachments 1 through 4, representing values within 5 seconds of the end of the recording. Example values from IDU serial number 36519 include⁴:

- TAWS was set to the inhibit position;
- Altimeter setting was 29.56 inHg;
- Above Ground Level (AGL) altitude used by TAWS: -376 feet; and
- Altitude indicated on the IDU was 1,154 feet.

3.2. Time Correlation

Each IDU record contains GPS date and time recorded in UTC. The data was converted to AKDT by subtracting 8 hours.

3.3. Plots and Corresponding Tabular Data

The following nine figures contain data recordings from June 25, 2015. According to the Investigator-in-Charge, all flights were flown by the accident pilot. Google Earth was used to overlay the data on satellite imagery. The weather, season, and lighting conditions in Google Earth are not representative of the conditions at the time of the accident.

Figure 5 shows an overlay of all recorded flights. The first recorded flight (Log 4) was from Misty Fjords to Ketchikan starting at 0837:37 AKDT. The last recorded flight (Log 0) was the accident flight from Misty Fjords towards Ketchikan. Table 1 summarizes each flight.

³ CRT=+ means that for any parameter recorded that indicates a climb or a right turn, the sign for that value is positive. Also, for any parameter recorded that indicates an action or deflection, if it induces a climb or right turn, the value is positive. Examples: Right Roll = +, Left Aileron Trailing Edge Down = -, Right Aileron Trailing Edge Up = +, Pitch Up = +, Elevator Trailing Edge Up = +.

⁴ According to the manufacturer, the IDU software version did not record the status of the synthetic vision display on either IDU (i.e., if color-coded warnings were displayed on the PFD or MFD).

Table 1. Summary of five recorded flights.

Log	Start AKDT	End AKDT	Direction
4	0837:37	0916:04	To Ketchikan
3	0938:37	1020:12	From Ketchikan
2	1032:22	1103:49	To Ketchikan
1	1118:49	1152:08	From Ketchikan
0	1206:57	1216:36	To Ketchikan

Figures 6 through 8 show the prior flight from Misty Fjords to Ketchikan. The recording began at Nooya Lake, over Rudyerd Bay, over Behm Canal, and over Ella Lake. About 10 miles east of Ketchikan, N270PA began a climbing turn, reversing course; followed by a descending turn of about 270 degrees. The flight then continued to Ketchikan.

Figures 9 through 13 show the accident flight. The recording began from Rudyerd Bay at 1206:57 AKDT with an indicated airspeed of 93 knots and an indicated altitude of 14 feet.⁵ Comparison with other factual data of the case, as well as the indicated airspeed at this time, indicate that N270PA was already airborne by this time, as shown in figure 11.⁶

N270PA proceeded west, over Behm Canal, and over Ella Lake. At about 1214:00 AKDT, N270PA began to climb and at about 1215:55 AKDT, the aircraft turned right. The three-dimensional flight path shown at the end of figure 9 shows an inverse projection of altitude; this is because the recorded indicated altitude was below the terrain elevations in this area.

The corresponding tabular data used to create these overlays and plots are provided in electronic (*.csv⁷) format as attachment 5 to this report.

⁵ AHRS units require a period of time to become aligned upon startup; this time may be extended on an unstable surface, such as water. Some floatplane operators may not turn the Chelton unit on until the aircraft is airborne and stable. This Chelton startup mode of operation may have been in use for the accident flight.

⁶ See the Personal Electronic Devices and Cameras Factual Report in the public docket for this accident.

⁷ Comma Separated Value format.

Figure 5. Annotated overlay of all recorded flights.

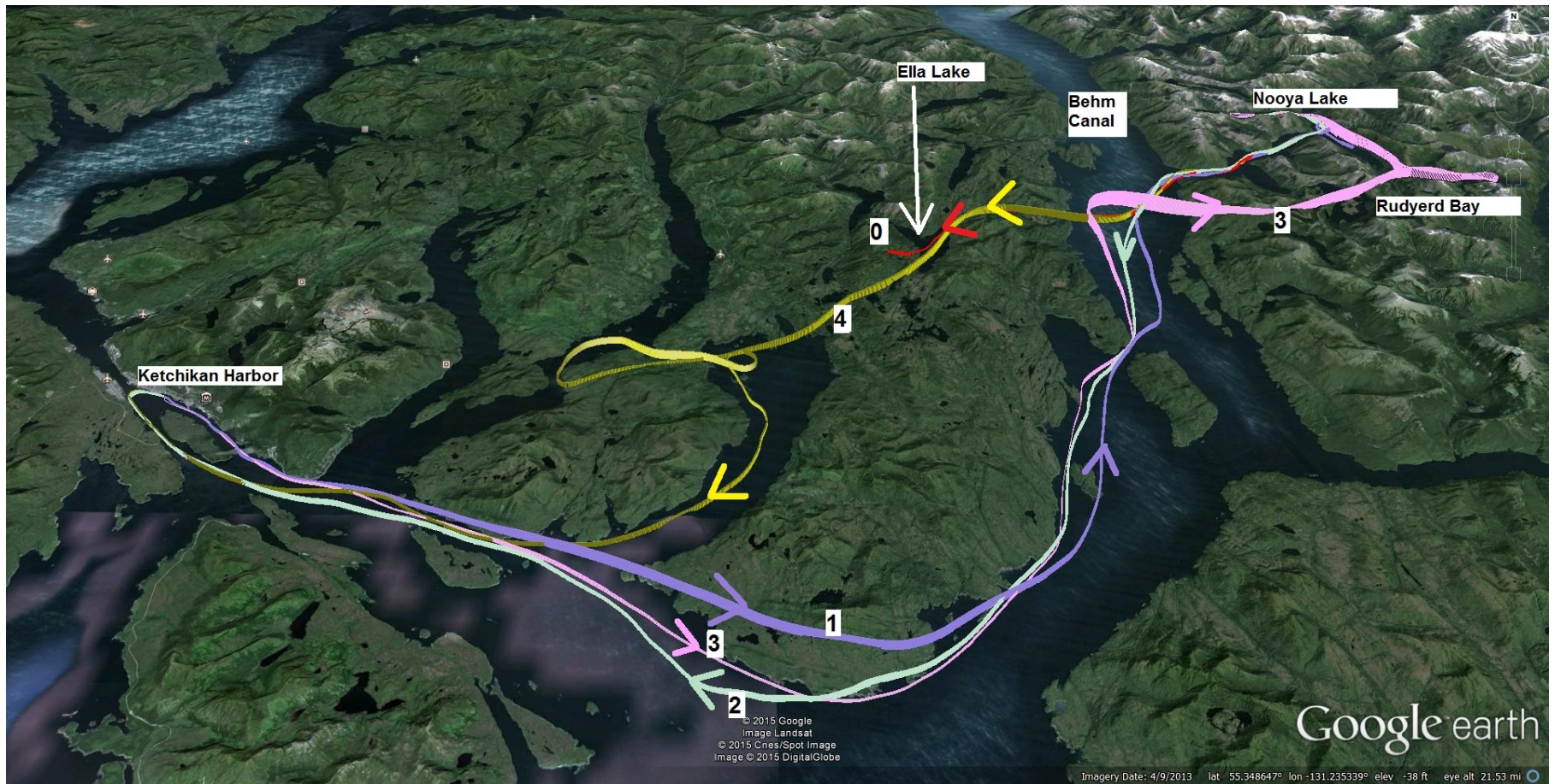
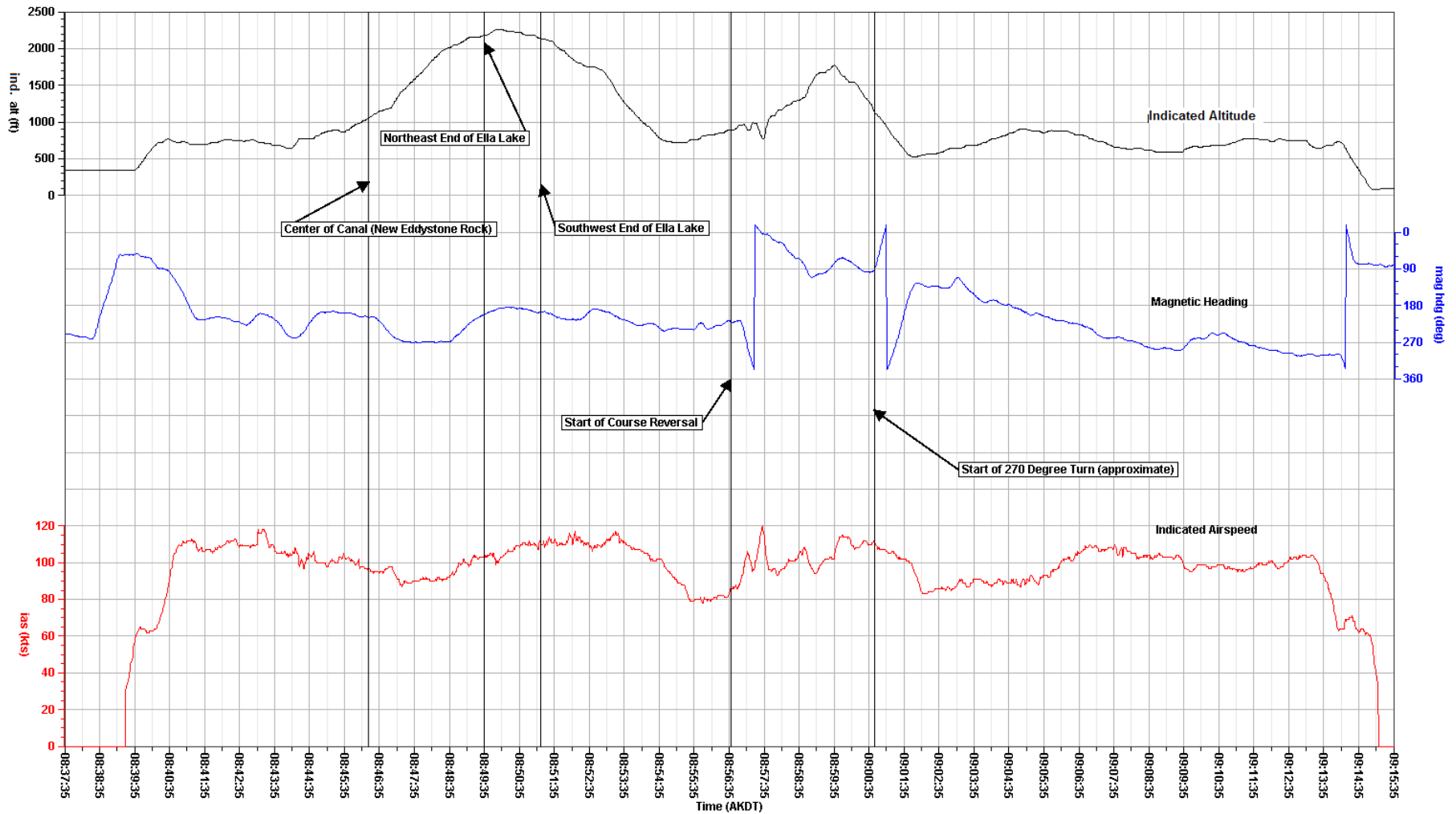


Figure 6. Overlay of Log 4 Flight to Ketchikan (over Ella Lake).



Figure 7. Log 4 Flight to Ketchikan (over Ella Lake).



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Log 4 Flight - Misty Fjords to Ketchikan

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Figure 8. Log 4 Flight to Ketchikan (over Ella Lake) – sectional view.

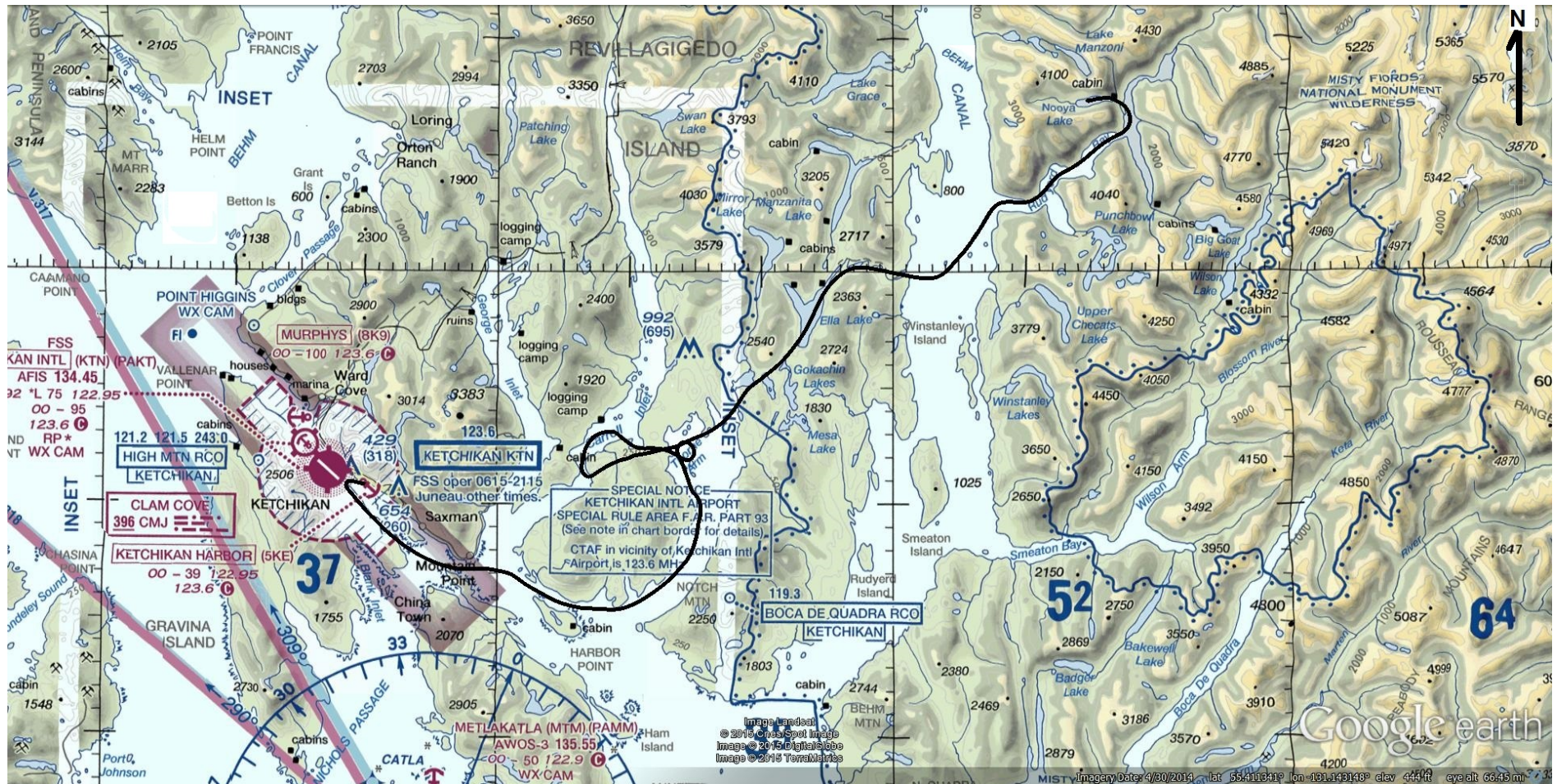


Figure 9. Log 0 – overlay of accident flight.

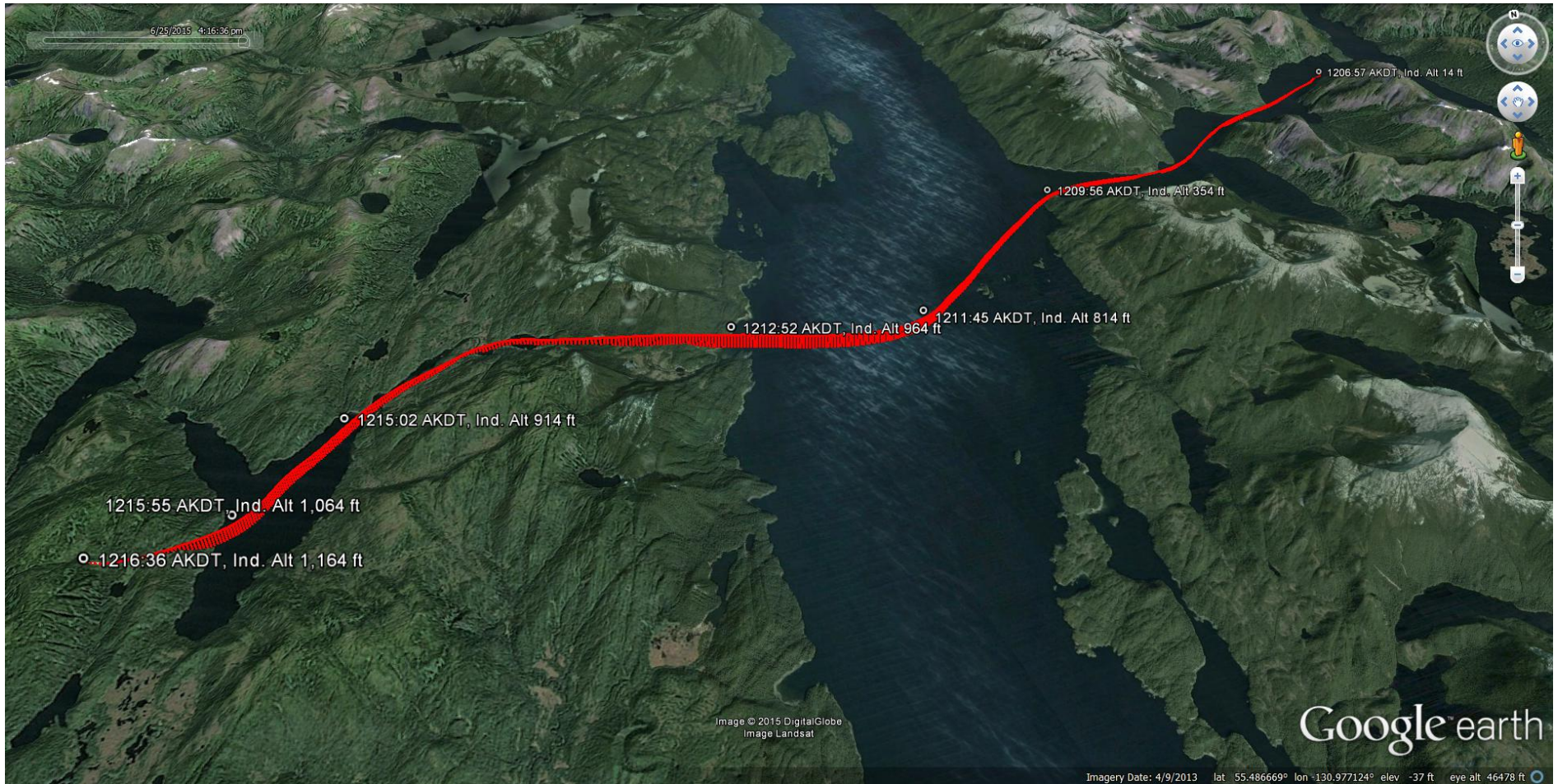


Figure 10. Log 0 – overlay of end of accident flight.

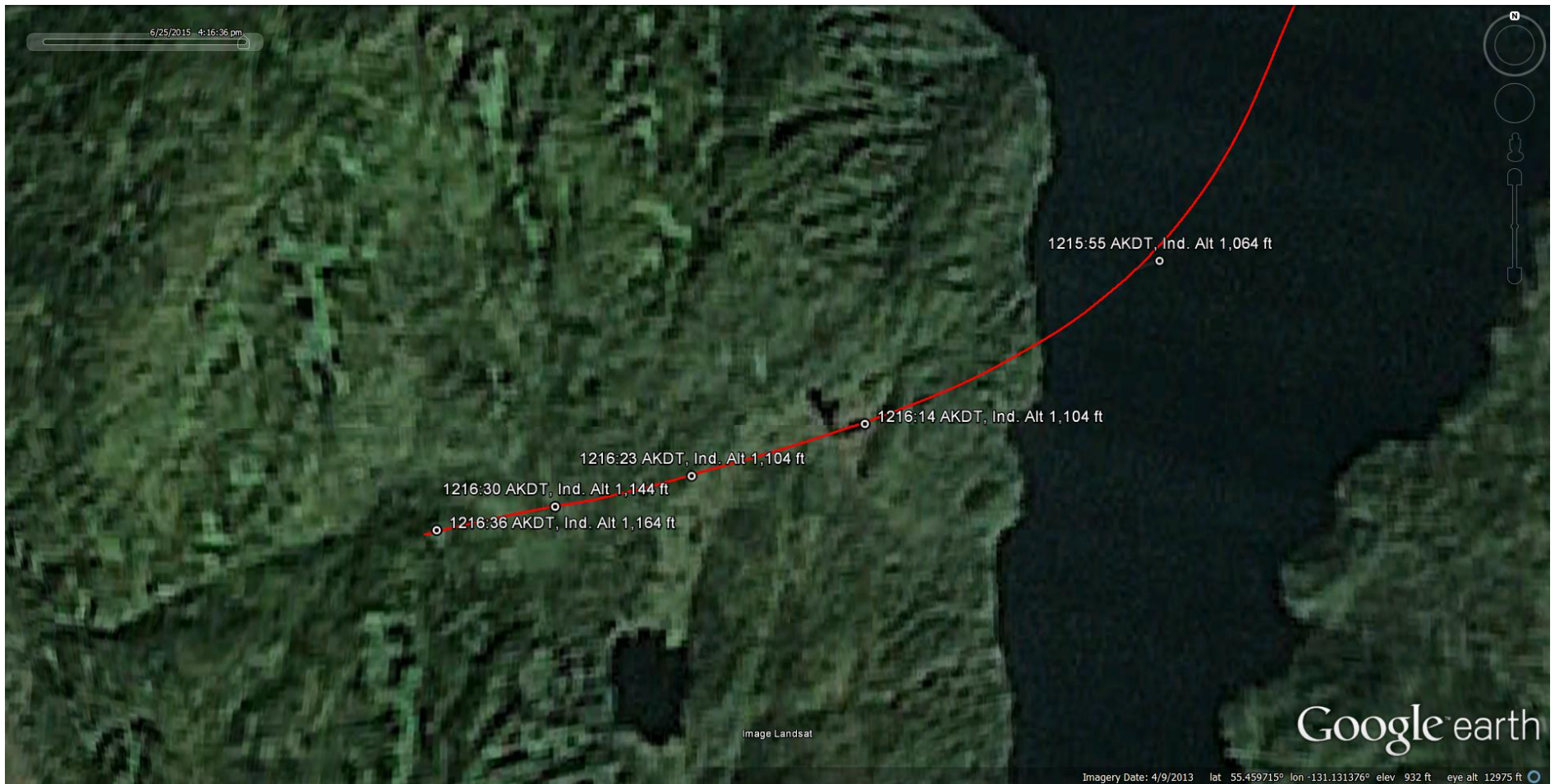
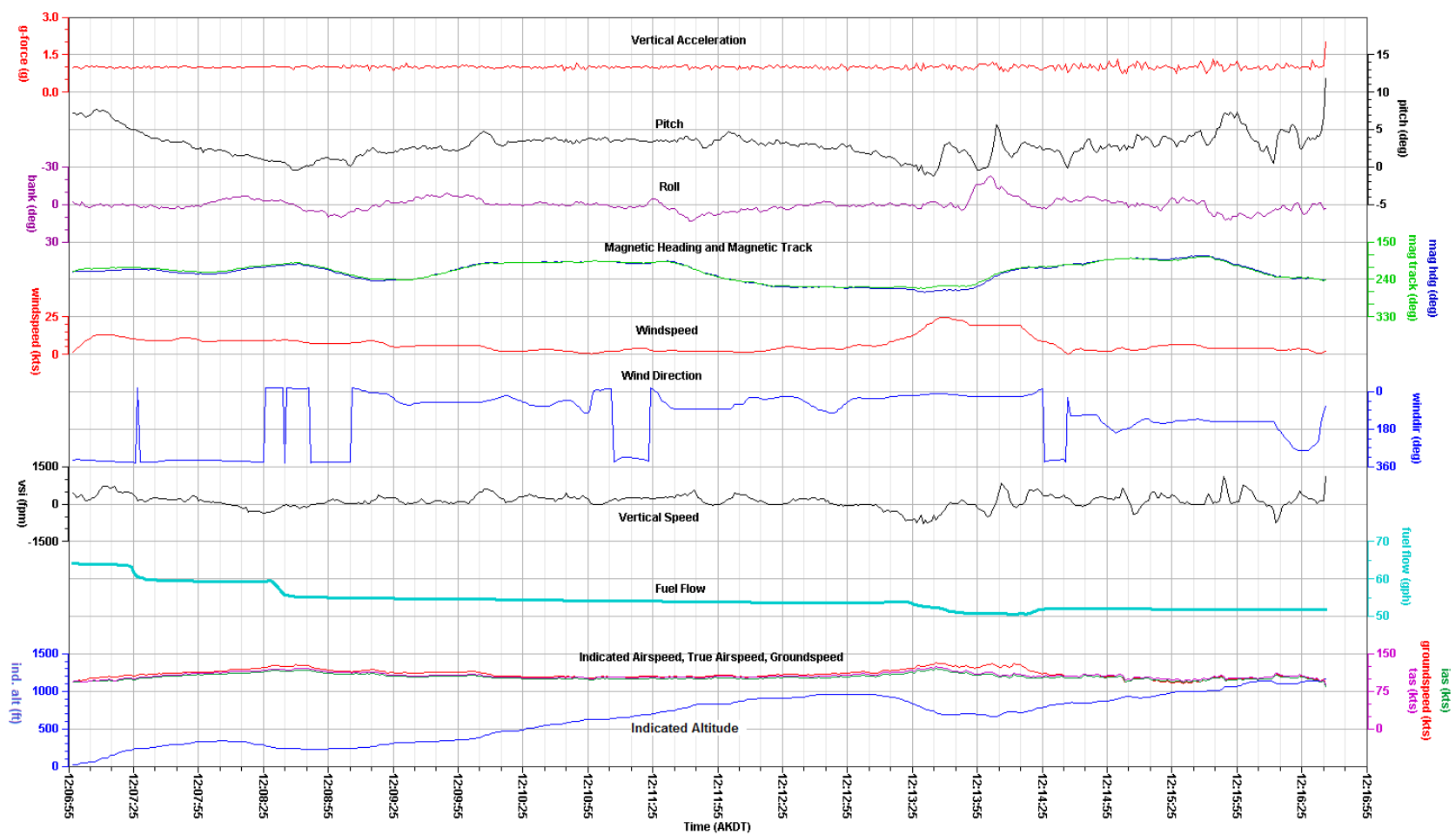


Figure 11. Start of Chelton accident flight recording combined with other factual data.



Figure 12. Log 0 – plot of accident flight.

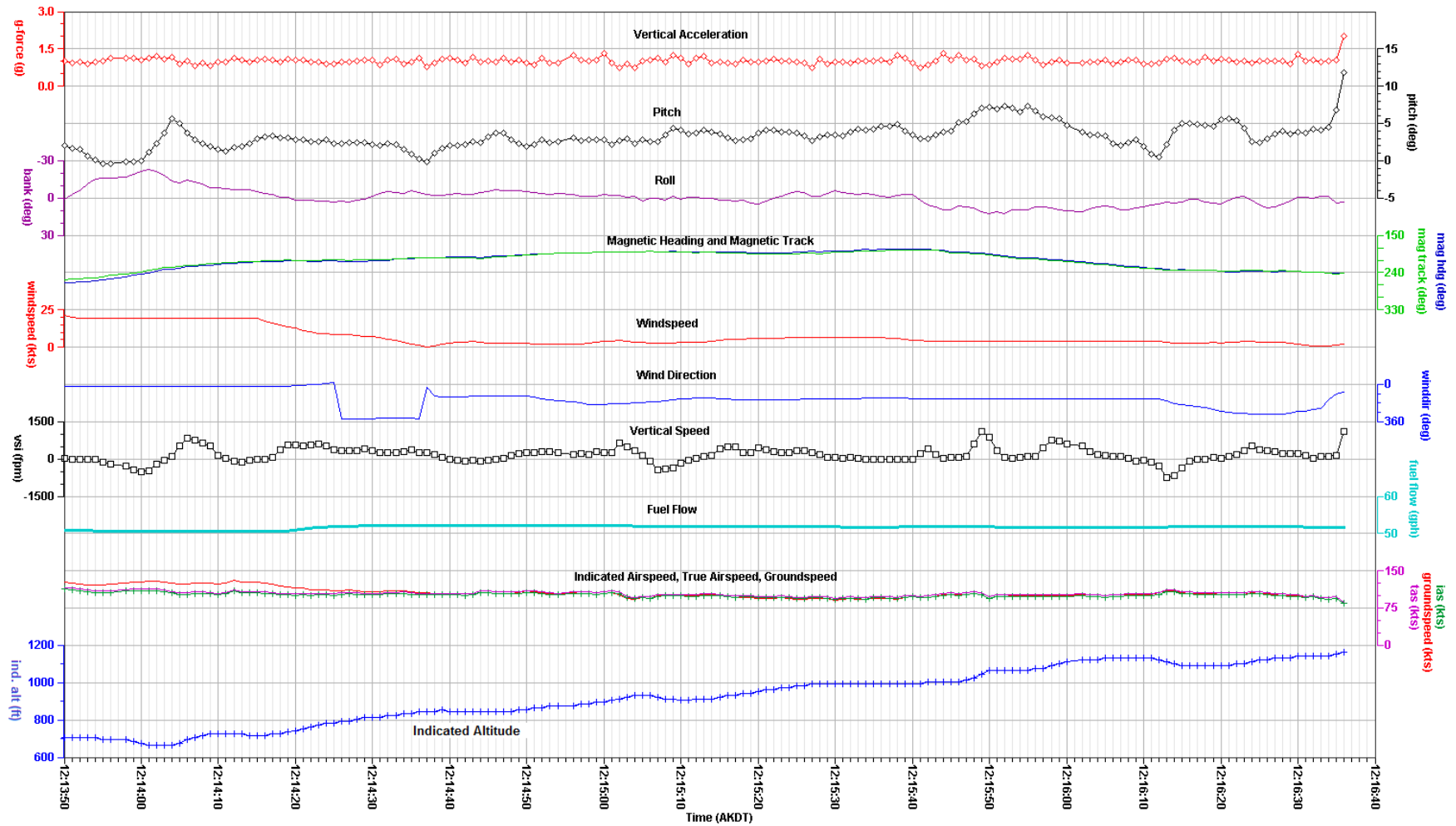


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Accident Flight - All

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Figure 13. Log 0 – plot of end of accident flight.



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Accident Flight - End

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APPENDIX A - IDU Parameters

This appendix describes the parameters provided and verified in this report. Table A-1 lists the PFD parameters and table A-2 describes the unit abbreviations used in this report for PFD parameters.

Table A-1 - Verified and provided parameters.

Parameter Name	Parameter Description
bank (deg)	Roll Angle
densAlt (ft)	Density Altitude
fuel flow (gph)	Fuel Flow
g-force (g)	Vertical Acceleration
groundspeed (kts)	Ground Speed
ias (kts)	Indicated Airspeed
ind alt (ft)	Indicated Altitude
lat (deg)	Latitude
Log	Log Number (see Table 1)
long (deg)	Longitude
mag hdg (deg)	Magnetic Heading
mag track (deg)	Magnetic Track
oat-Fahr (degF)	Outside Air Temperature
pitch (deg)	Pitch Angle
tas (kts)	True Airspeed
time (hh:mm:ss)	UTC Time
vsi (fpm)	Vertical Speed
winddir (deg)	Wind Direction
windspeed (kts)	Wind Speed

The IDU records altitude as shown on the IDU, which is based on the altimeter setting set by the pilot.

Table A-2 - Unit abbreviations.

Units Abbreviation	Description
deg	degrees
degF	degrees Fahrenheit
fpm	feet per minute
ft	feet
gph	gallons per hour
hh	hours
kts	knots
mm	minutes
ss	seconds